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ABSTRACT

This paper was developed to describe and discuss the characteristics of educational settings and school science curriculum in Japan as compared with the United States. Three major aspects of the role of science education are presented. The first is the cultural and societal expectations placed on education. This represents external influences on education which, in turn, tend to affect the nature of school science curriculum. The second aspect is a description of the organization of the educational systems and school curricula in both countries. The purpose of this section is to compare the context and management of factors which help to define the nature of school science curriculum. The third part of this summary is an inside look at the science curriculum in Japan contrasted with a perspective on the nature of the science curriculum in the United States. A 26-item reference list and an appendix containing test score data in three tables and two figures are included. (TW)

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PERSPECTIVES ON EDUCATIONAL SETTINGS AND SCHOOL SCIENCE CURRICULA IN JAPAN COMPARED WITH THE UNITED STATES

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May, 1987

Greenville, North Carolina

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PERSPECTIVES ON EDUCATIONAL SETTINGS AND SCHOOL SCIENCE CURRICULA IN JAPAN COMPARED WITH THE UNITED STATES

Introduction

The central purpose of education is to nurture the development of young people as complete individuals with cognitive, affective and psychomotor skills harmoniously and fully integrated. In order to help attain this purpose, science, as a specialized subject focused on the natural things and phenomena, is required in school curriculum.

To learn differences and similarities of educational settings and science education from other countries is to know ourselves, and this can lead to better education in the future. Nationwide surveys to assess students' thinking skills as well as achievement in science have been undertaken. Significant differences among the students in various countries were reported. The major concern and issue for educational researchers is to find the cause of the differences in thinking skills and achievement levels among these students. By identifying and pursuing the commonalities shared by different countries, it may be possible to develop a set of universal principles of educational foundations and science curriculum development.

The purpose of this report is to describe and discuss the characteristics of educational settings and school science curriculum in Japan as compared with the United States. There are many parallels between the two countries and by examining each from a national perspective, it may be possible for people in each country to understand the role of science education in the other. Such an understanding of the

similarities and differences in the patterns involved can lead to a synthesis of perspectives and perhaps, ultimately, to the goal mentioned above.

In this paper, three major aspects of the role of science education are presented. The first is the cultural and societal expectations placed on education. This represents the external influences on education in general which, in turn, determine to a large extent the nature of the school science curriculum. The second aspect is a description of the organization of the educational systems and school curricula in both countries. The purpose with this part is to compare the context and management of factors which help to define the nature of the school science curriculum. The third part of this summary is an inside look at the science curriculum in Japan contrasted with a perspective on the nature of the science curriculum in the United States.

I. Cultural and Societal Expectations on Education

It is important to acknowledge the influence of cultural and societal values on education in general and on the school science curriculum in particular. Education is a mirror of society. Therefore, the cultural and societal expectations must be considered as part of any educational setting.

Japan is a small island separated from other countries by oceans and its land area is about 1/25 of that of the United States. The U.S. is one of the most fertile agricultural lands and has many natural resources. On the other hand, 67% of Japan is mountainous and covered with forest, 15% is agricultural land, and 3% is residential land.(1) Japan has few natural resources. Under these geographic conditions, people are considered the most important resource in Japan. In other words, the development of "man power" is the hinge for social development.

To compare with the American society, Japanese society is characterized as homogeneous. Within the poulation, 98.6% of the people have pure Japanese origin and 90% of the people think of themselves as middle class in terms of socio-economic status.(2) Under these demographic conditions, social norms such as uniformity, conformity and group consciousness have been formed in this country. Also, a vertical social structure based on the seniority system where age and experience are appreciated, has been established. These social norms and social structure reflect upon education certain expectations which have profoundly determined the important role of education in Japanese society.

The objective of Japanese education seems to decrease the individual differences with special emphasis on teacher directed learning within the total group. In contrast with this, the objective of American

education seems to increase individual differences by encouraging student's self-directed learning in a less structured environment. In other words, to develop the specialist according to the individual competency, is highly admired in the United States. To develop the generalist in order to fit into the whole society, is the major concern in Japan. Of course, neither emphasis is completely exclusive of the other--in both countries, both goals are important.

Since World War II, Japan has succeeded in transforming society into an economically and industrially developed country. These successes could never have been attained without the educational efforts which promote the "man power" as total group. Education in Japan has been looked upon as a means for training highly qualified manpower and for teaching a common culture equally to all people. However, there exists the weakness behind the success. Up until recently, technological development in Japan has been based upon the copies and clever combinations of technical ideas imported from overseas. Few new or original ideas or knowledge can be found. Even greater efforts toward the development of new and original technology are now becoming an important expectation placed on the educational system.

In addition to the expectations on education for transforming society, Japanese believe that individual success in education leads to personal advancement and education can change the individual social status. Thus, families invest enormous amounts of time and energy in promoting the educational success of their own children. In terms of mothers' attitudes toward their children's education and success in school, Japanese mothers place much more emphasis on effort (over ability) than mothers in the United States.(3) Such differences in beliefs and

attitudes toward education are evidenced by the emphasis placed on the need for and importance of after school school, or "Juku" for additional learning. Preparation for entrance examinations is apparently a rather unique Japanese educational characteristic and may be considered a direct outcome of societal expectations.

Education is the greatest concern in Japanese society. For the 21st century, Japan has recently begun to "shift gears" in education from both a national and an international perspective. Major issues in educational reform, which have been argued in Japan since 1984, are as follows:(4)

1. Basic requirements for an education relevant to the 21st century.
2. Organization and systemization of lifelong learning and correction of the adverse efforts of undue emphasis placed on the educational background of individuals.
3. Enhancement of higher education and individualization of higher education institutions.
4. Enrichment and diversification of elementary and secondary education.
5. Improvement in the quality of teachers.
6. Coping with internationalization.
7. Coping with the information age.
8. Review of education administration and finance.

The internationalization and individualization in education, and development of creativity are main slogans in this reform. Japan is now facing the turning point where the traditional introversive viewpoints within the groups need to be replaced by the extroversive ones, which are

opposite in direction in thinking beyond the homogeneous dimension. Japan has many things to learn from other countries, especially the free society, the United States.

II. Organization of Educational Systems and School Curricula

Similarities between the educational systems of Japan and the United States dominate in most any analysis of the overall structure of each, but important differences do exist. Both countries can benefit by a comparison of the specific conditions and factors that determine or influence the nature of the school science curriculum. Since the goals of education are much the same worldwide, it is important to identify the most effective means to organize and implement an educational system to achieve those goals.

A. Organization of Educational Systems. In general, the structure of education in the United States and in Japan are the same in terms of school levels, including elementary, junior high or middle school, high school and university or college. Education is compulsory from the ages of five to sixteen in the United States, and ages six to fifteen in Japan. However, there are significant differences in terms of grade level structure in school organization and grouping of students, such as tracking and mainstreaming systems.

In Japan, the most common pattern of precollege school systems is characterized as the 6-3-3 system. Children at about the age of six enter elementary school for a period of six years. This is followed by three years of lower secondary school and three years of upper secondary school. Elementary and lower secondary school level is compulsory. After compulsory education, upper secondary school as regular school is different in terms of the type of courses and the content of teaching. There are three types of upper secondary school patterns. They are full-time (3 years), part-time, and correspondence (four years or more)

courses. Regarding the content of teaching, the upper secondary school course is classified into two categories: the general course for both those who wish to advance to higher education and those who are going into employment, and the specialized vocational courses for those who have chosen a particular vocational area as their future career. Almost 70% of the students in upper secondary school are enrolled in general courses. There are also a number of special training schools and miscellaneous schools other than these regular upper secondary schools.

In the United States, the grade level structure of schools may vary within each school district, and the pattern is not as uniform as the 6-3-3 system in Japan. Grouping of students is normally done according to each student's competency. In regular schools, although the majority are grouped by age, students may be grouped as academically gifted, regular and special education in an attempt to create more homogeneous groups. This is the so-called tracking system. Also, there exists a mainstreaming system which places special students into a normal classroom setting so that they may benefit from all the experiences that regular students have.

In Japan, students are usually heterogeneously grouped by the same age, although there are special education schools for handicapped children which separates those individuals. By maintaining same age groups, interaction among students with different competencies is encouraged.

In both countries, <u>equal opportunity</u> of education for every student is one of the main educational policies stated in each national education law. However, as mentioned before in the cultural and societal expectations on education, the interpretation of this concept has resulted in differences in the organization of the two educational systems. The American system has multiple tracks where individual students may be

matched by ability and learn according to their needs and competency. On the other hand, the Japanese system has a single track where most of the same age group students are expected to stay with that group throughout their formal education.

In Japan, almost 100% of the eligible students are enrolled in compulsory education. About 94% of the students are enrolled in post-compulsory education; therefore, upper secondary school is almost universal. Also, almost all students finish their secondary education. In the United States, retention to high school graduation (about age 18) varies from region to region. A large majority of the high retention states are located in the Midwest where Minnesota has the highest retention rate of 86%. A majority of the low retention states are in the South and Southeast where, for example, Mississippi has the lowest retention rate of 61.8%.(5) Such regional differences are not commonly found in Japan. This might be a result of a centralized school system while the school system in the U.S. is very decentralized, with many of the key educational policy decisions made by the states or by communities within states.

About 33% of Japanese upper secondary school graduates continue on to higher education, whch is lower than in the United States. There has been much publicity about the rigid entrance examinations in Japan, where students need to get the highest score they can to be competitive for admission to a college or university. In the U.S., students are required to take the Scholastic Aptitude Test (SAT) and achieve more than the minimum score for entrance into a college or university. The minimum score varies from one institution to another depending on many factors, including the number of students applying, cost, and the location and

reputation of the institution, among other things. In Japan, in a sense, to pass the entrance examination might be considered as a final goal of pre-college education. Thus, after school school (Juku) has been widely accepted by the public, because it can give students a competitive edge in taking the critical examination. This mght be one of the characteristic outcomes produced by public education in Japan.

B. Curriculum Decision Making. The intended curriculum is reflected in curriculum guides, course outlines, syllabi, and textbooks adopted by school systems. In Japan, national curricula, or the "course of study," emanate from the Ministry of Education, Science and Culture. In the United States, such statements of intended goals and curricular specifications come from state departments of education and from local school districts. The degree to which such guidelines are mandatory vary from state to state. Many states provide voluntary curriculum guidelines, hence, local authorities have had considerable discretion as to the content to be covered. However, the recent reform movement has seen increasing emphasis on state guidance and state assistance. Statewide mandates for testing tend to generate a common core of curricular content.

The national course of study provides the basic framework or outline for school curricula throughout the schools in Japan, resulting in a uniform and centralized standard for education. For each level, elementary, lower secondary and and upper secondary, a course of study contains overall objectives, specific objectives and a brief outline of content to be developed for each field. Preparation of the teaching programs and special considerations in teaching are also included and consist chiefly of brief discussions on how much time should be allotted

to each of the fields and some suggestions for emphasis in teaching. These courses of study are relatively brief and lacking in detail as compared with those developed in the United States school systems. The subjects to be offered in elementary, lower secondary and upper secondary schools, as well as the standard number of annual teaching hours to be devoted to each subject, are spelled out in the "Enforcement Regulations for the School Education Law" and enforced by the Ministry of Education, Science and Culture.

Based on this official curriculum, local boards of education, which are in every one of 47 prefectures in Japan, develop the standard curriculum and provide the necessary guidance, advice and assistance to each school. Each school organizes its own practical curriculum in accordance with the above-mentioned provisions and takes into consideration the real circumstances of the school and its location as well as the abilities, aptitudes and future prospects of the students enrolled.

In comparison, the level of decision making regarding the intended curriculum illustrates a significant difference between the two countries. In Japan, the decisions about the curriculum are centralized and relatively standardized throughout the country. In the United States, the decisions have traditionally been established at the state level, with successful programs often developed by individual school districts. One of the goals of the current reform effort in the U.S. is to develop greater uniformity of standards, but the enormous diversity among student populations has and will continue to limit progress in this area. However, there seems to be similarity in that the intended goals and contents are stated as official document, and teaching methods and

evaluation activities are expected to be devised by each school district and its teachers.

As just described with the intended curriculum, although the source may be different, many decisions are made at the school level which result in what may be referred as to as the implemented curriculum. Input for the implemented curriculum may come from sources such as textbooks and examinations which are related to teaching methods in classroom and evaluation activities. In Japan, textbooks required for use in classroom teaching of each subject in all elementary and secondary schools are authorized by the Ministry of Education, Science and Culture. These are inevitably based on the national course of study. Local boards of education adopt textbooks to be used in local schools and adoption is made every three years. In the United States, there is no textbook authorization system such as in Japan. In the United States, textbooks are published by highly competitive textbook publishing companies, and adoption decisions are usually made at school or school district levels. Many states limit the options to help ensure consistency with established state curriculum guidelines or competency examinations. The influence of textbooks in the implemented curriculum may be decisive in both countries; but, as described, the authorization/adoption systems and the content coverage of the intended curriculum are different.

The influence of external examinations on the implemented curriculum seems to be significant in both countries. In the United States, 42 states (in 1986) had minimum-competency examinations administered to public school students at designated grades in the K-12 sequence. These examinations are used as one criterion for grade promotion or for graduation, not necessarily as any type of entrance

exam. Sometimes contents of these state mandated examinations might not exactly correspond to the intended curriculum in that state. These external examinations influence the implemented curriculum in addition to the expectation from the intended curriculum. In contrast to Japan, there is relatively less coordination among the different levels of education and consequently, the discrepancy between the intended curriculum and implemented curriculum is greater in the United States.

In Japan, the terminal uniform examinations, which are the entrance examinations for public upper secondary schools at prefectural level and nationwide examination for national and public (prefecture and city) university called "Joint First Stage Achievement Test," are standardized based upon the national course of study. However, because of the highly competitive nature of the Japanese education system, there is a great deal of pressure to do well on the entrance exams. As a result, the implemented curriculum is influenced by the examinations, but it is also very consistent with the intended curriculum.

In terms of evaluation of curriculum for the purpose of improvement of the intended curriculum, the Ministry of Education, Science and Culture of Japan conducts investigations and surveys on the condition of curriculum implementation. Based on these results, national courses of study (at each level) are revised every ten years. Such a nationwide evaluation does not exist in the United States. In both countries, however, the schools and teachers have the responsibility for developing an appropriate curriculum and assessment plan. In the U.S., the decentralized system of education provides considerable latitude for individual teachers to modify the curriculum for their students and communities. This freedom may result in the existence of nonconformities

in the curriculum between grades within schools or between different schools at the same grade level. In Japan, on the other hand, the centralized system of education may provide uniformity of curriculum implemetation throughout the nation. Although the schools and teachers are under this control, they are still expected to develop and improve their own curriculum. Besides the conferences and workshops conducted by local boards of education, there are various kinds of teachers' group meetings in each school and within school districts to improve their own curriculum as well as their teaching skills. These meetings are normally focused on the assessment of classroom teaching and lesson plans. This "freedom under control" for curriculum decision making is one of the characteristic aspects of educational settings in Japan.

C. Nature of School Curriculum. The central government of Japan drafts a course of study prescribing the content of the curriculum and inspects commercial textbooks to ensure that they conform to the official standards. One virtue of this procedure is that children throughout the nation are exposed to a common body of knowledge in an identical sequence.

One of the principles underlying the course of study (1977 and 1978) is to bring up children who are balanced in intellect, morality and physical power, and full of humanity.(6) Under this principle, Japanese school curriculum comprises both curricular activities, which are intellectual subjects and practical subjets teaching, and extra-curricular activities which consist of moral education and special activities. At the compulsory levels in curricular activities, intellectual subjects such as Japanese language, social studies, arithmetic/mathematics, and science are taught for all students at each grade level in elementary (1-6 grades)

and lower secondary (7-9 grades) schools. Foreign language (English) is taught from the seventh grade to the ninth grade as an elective subject. Practical subjects such as music, arts and physical education, are also taught for all students throughout the nine years of compulsory education. Homemaking/industrial arts is taught from the fifth grade to the ninth grade. Extra-curricular activities which include moral education and special activities (students' activities, school events, and classroom guidance) are also provided for all students in elementary and lower secondary schools.

In upper secondary school, which is post-compulsory education, the basic framework for curriculum is the same. However to enable students to concentrate more fully on selected subjects, the subject selection is based on the ability and aptitude of each individual, and a wide range of subjects is offered. At the 10th grade in upper secondary schools, a linkage is emphasized between the broad based general education offered by lower secondary schools and the more specialized fundamentals offered at the more advanced level.

The curriculum is demanding in Japan. It covers a wide range of subjects and pursues these in greater depth than is the case for the curriculum of a typical American school district. The differences are evident from the first grade of elementary school. Young Japanese pupils spend a larger proportion of their time in practical subjects such as music, art, and physical education than do American students. The emphasis in the Japanese schools on moral education, particularly during the early years of elementary school, is perhaps its most outstanding characteristic. It is responsible for a variety of other educational and social outcomes: the orderliness of the classroom and society, the

comparatively harmonious social interaction characteristic of Japan, and the unity and cohesiveness of the Japanese nation.(7) The Japanese people regard the school as the integration of individual growth of children and social culture to develop habits, customs, traditions and norms in order to create a new society and to make possible the attainment of self-realization. The nature of school curriculum in Japan includes an emphasis on the attainment of the full development of personality, and of humanity as a whole.

In order to cover the demanding curriculum, schools are required to operate an educational program for at least 220 days each school year, in contrast with 185 days for American schools.(8) In most cases, this means that students attend school five and a half days a week for over forty weeks. They begin the school year at the beginning of April and end the year at the end of March. Summer vacation is about one and a half months and students are given assignments to be completed over the summer. Winter and spring vacations are about two weeks long each. School occupies a very central place in the Japanese students' lives.

III. School Science Curriculum

Japan, as well as the United States, views science and technology education as very important. In the United States, the National Science Board Commission on Precollege Education in Mathematics, Science and Technology has stated the case for science and technology education as follows: "By 1995, the nation must provide, for all its youth, a level of mathematics, science and technology education that is the finest in the world, without sacrificing the American birthright of personal choice, equity and opportunity."(9)

In Japan, science education is considered as a key element in the industrial and economic growth of the nation. Science education has essentially contributed to the remarkable rapid growth of Japan in the last four decades after World War II, and will continue to be indispensable for the information age, the 21st century.

A. Aims and Objectives of Science Education. One of the universal goals of science education is the development of scientific literacy for all students. In order to attain this goal, each country has developed goals, concrete structure, and proper scope and sequence of various teaching contracts based on the developmental levels of the learners. The overall objectives of science education in Japan are stated in the "Course of Study for Elementary Schools (1980)," "Course of Study for Lower Secondary Schools (1981)," and "Course of Study for Upper Secondary Schools" (1982).

Overall objective of elementary school science: To develop the ability in and attitude toward making inquiries about nature through observations and experiments as well as to enhance the understanding of

natural things and phenomena, thereby, nurturing a rich sensitivity to love nature.(10)

Overall objective of lower secondary school science: To develop students' ability in and positive attitudes toward making inquiries about nature through observations and experiments as well as to enhance the understanding of matter and phenomena in nature. Thus, to have students realize the relationship between nature and human beings.(11)

Overall objective of upper secondary school science: To develop students' ability and positive attitudes to inquire into nature through observations and experiments, to enhance their understanding of fundamental concepts of matter and phenomena in nature, and to develop students' scientific view of nature.(12)

These overall objectives for science education in Japan are categorized into four main objectives: knowledge and understanding, scientific thinking skills, observation and experiment skills, and interest and attitude toward nature. To attain these objectives, inquiry about nature through observations and experimentation is emphasized as approaches to learning for all school levels.

In the United States, the goal for science education in the 1980s is categorized by the National Science Teachers Association (NSTA) into four general objectives: concept development, process skills, application to the students' personal lives, and science-based social issues. Academic knowledge of science and technology, practice and applications of science process skills which involve developing laboratory aptitudes and cognitive abilities, and application of knowledge and skills in daily life and society are broadly described.(13)

There are differences between the goals of Japanese school science

and those of American school science. There seems to be a much greater emphasis on positive attitudes toward the natural environment in Japan. An attempt is made to develop an appreciation, love, and respect for life and realization of the influence of the natural environment on humans in Japan. On the other hand, in the United States in order to develop an informed citizenry that can make prudent decisions on scientific/ technological issues, application of knowledge and skills into daily life and society seems to be emphasized. Science, technology, and society (STS) as they relate to education are also important; and in the next new course of studies in Japan, applied science will be introduced on this matter, especially at the upper secondary school level as elective subjects.

B. Scope and Sequence of School Science Curriculum. To attain the general goals of school science education, curriculum contents are organized at each grade level, based on the developmental stages of the learners. The characteristics of content organization are reflected on the scope and sequence which are the breadth and depth of teaching contents.

In the United States, there are great variations in science curriculum organization among states, local school districts, and schools. Therefore, it might be difficult to generalize the patterns of organization of science curriculum. However, in general, two common patterns can be identified.(14) The difference between the two patterns of science curriculum organization in the United States is in secondary school programs. One is called "layer cake" approach, in which a different academic area in science is taught each year. The other pattern

is the integrated science approach at the middle grade levels. Elementary school science programs are not standardized in the American schools. Content may include units from any one, or all of the basic or applied sciences. At the lower secondary school level, courses in general science, physical science, biological scinece, and earth science are often offered. Less frequently, an integrated science course is offered. At the upper secondary school, the science curriculum is usually a full year sequence in one branch of science. For example, a common pattern is to have biology in the tenth grade, chemistry in the eleventh grade, and physics in the twelfth grade. Since many states require no more than two years of upper secondary science credit for graduation, the numbers of students enrolled in science courses at the eleventh and twelfth grades are fewer than previous levels. A 1980 survey indicated that almost all American high school students study at least one science, more than 50% of them take two or more years of science and more than 20% take three or more years.(15) NAEP data indicate 84% of students do not take physics, 65% do not take chemistry, 23% do not take biology.(16) Since 1983, most states have moved toward increasing high school graduation requirements in science courses from one year to two years. By 1989, at least 24 states will require two years of science.(17)

In Japan, on the other hand, the scope and sequence of school science curriculum are evidenced clearly in the national course of studies. At the kindergarten level which is not compulsory, science as a subject is not part of the curriculum, but would appear in a very elementary way,emphasized in the activities oriented within the areas of health and nature.

At the elementary school level (1-6), science is taught as a

general science for all students. From the third grade this general science is divided into three subparts which are "Living Things and Their Environment (A part)", "Matter and Energy (B part)", and "The Earth and the University (C part)." The strength of elementary school science curriculum is that there is a clear vertical structure based on the three subparts which are co-related with each other throughout the elementary school years. However, there might be a weakness of poorly corrected units to be taught at each grade in terms of horizontal structure.

At the lower secondary school level (7-9), science is taught as combined sciences for all students. The "Matter and Energy" part in elementary school science is deepened in one of the combined sciences called "first field" which is the physical and chemical area. "Living Things and Their Environment" and "The Earth and the Universe" parts in elementary school science are deepened in the other of the combined sciences called "second field" which is the biology and earth science area. These two fields are usually taught reciprocally according to the seasons or parallel at the same time.

At the upper secondary level (10-12) which is post-compulsory, the contents of science are divided into six subjects, Science I, Science II, Physics, Chemistry, Biology, and Earth Science. Science I is a required subject for all students in the tenth grade and it is taught as an integrated science which covers basic academic discipline contents such as "Force and Energy," "Construction of Substances and Their Changes," "Evolution," "Balance of the Natural World," and "Man and Nature." Science II and other separated disciplines are elective subjects at the eleventh and twelfth grades. Among these five elective subjects, two or more subjects are required. As a matter of fact, all students study

science, at least one subject, each year in the upper secondary school.(18) Among elective subjects, Chemistry, Physics, and Biology are widely studied, while almost no students take Science II.(19) The subject selection percentage in Joint First Stage Achievement Test (JFSAT), which was introduced in the university admission system in 1979, shows that the combination of physics and chemistry is the most common and the chemistry and biology combination is the next.(20) This implies that subject selection in the entrance examination for the higher education may influence the course selection in the upper secondary school science.

As described above, in Japanese schools, science is taught for all students at each grade level through kindergarten to twelfth grade according to the course outline stated in the national courses of study. In the United States, the scope and sequence of science curriculum are made at the state and local school district level and there is no identifiable course outline at the national level. These differences in curriculum organization are the result of differences in school system, which is a centralized system in Japan while the American system is decentralized. In general, the greatest differences of school science curriculum can be seen at the secondary school level. In Japan, the multiple sciences are included each year of the secondary school. In the United States, typically just one science is taught in each course each year. Also, there are differences in the amount of time devoted to science teaching in the upper secondary school. At the upper secondary school level, Japanese students take more sciences than most of the American students. Of course, there are similarities in elementary school science and integrated science at the middle grades in terms of the

pattern of curriculum organization in both countries.

The time allocation for science teaching in Japanese schools is recommended by the Ministry of Education, Science and Culture. In the elementary school, the total number of class hours are 68 for the first grade, 70 for the second grade and 105 for the third, fourth, fifth and sixth grades each. Science is taught two periods per week at the first and second grades, and three periods per week from third to sixth grades, where the time for one period is 45 minutes. Among these teaching hours, about 80% for the lower grades, about 70% for the intermediate grades, and about 60% for the upper grades in elementary school are recommended to allocate to practical activities and laboratory work. In the lower secondary school, the total number of class hours is 105 for the seventh and eighth grades each and 140 for the ninth grade. Science is taught three periods per week at the seventh and eighth grades and four periods per week at the ninth grade, where the time for one period is 50 minutes. Among these teaching hours for science, about 30% for seventh grade and about 20% for ninth in lower secondary school are recommended to allocate to practical activities and laboratory work. In the upper secondary school, the total number of class hours is 140 for Science I, Physics, Chemistry, Biology, and Earth Science. These subjects are taught four periods per week, where the time for one period is 50 minutes. Among these teaching hours for each subject in science, about 15% is recommended to allocate for practical activities and laboratory works.(21)

These figures show that most of the time for science teaching in elementary school is devoted to the practical activities and laboratory works where the inquiry about nature through the "hands on" activities is emphasized. As the grade level proceeds to the higher, less emphasis is

put on the practical activities and laboratory works where the hypothetical-deductive approaches may be predominant in the inquiry about nature. The American data on this matter are not applicable for the purpose of the comparison at the national level. Teaching approaches to science greatly depend on the classroom teachers in each school in the United States. Of course, the final decision making of science teaching is made by each classroom teacher in Japan as well as the United States.

In both countries, elementary school science is generally taught by the generalist classroom teacher in the self-contained classroom. This teacher has the responsibility for the instruction in most of the subjects in the elementary school curriculum. Beginning with seventh grade in both countries, most of the science instruction becomes departmentalized and most of the sciences are taught by the specialist science teachers.(22) In the United States, the secondary science teachers (7-12 or 9-12) are usually certified in an academic area such as physics, chemistry, biology or earth science. On the other hand, in Japan, the secondary science teachers (7-9 and/or 10-12) are generally certified in science which covers all academic areas. These differences in teachers' certification might be related to the differences in science teaching approaches in secondary schools, where a single science is taught each year in the United States, while the multiple sciences are taught each year in Japan.

C. Attained Science Curriculum. The intended curriculum is reflected in curriculum guides, and course outlines as described, analyzed and discussed in the previous sections. The implemented curriculum focuses on the classroom teaching where the individual teacher interprets and puts into practice the intended curriculum and students are actually

exposed to it. Translation of intended curriculum guides into programs for classes actually depends upon each teacher. Thus, their selection of content or pattern of emphasis may not be consistent with those intended and differ in each classroom. The attained curriculum is what students have learned as a result of experience exposed in the classroom and usually measured by tests and questionnaires. In this section, the results of national assessment and international assessment of students are described, analyzed and discussed in terms of the development of cognitive skills in science.

The national survey on the condition of curriculum implemetation was undertaken in order to determine the level of understanding of the learners about the educational content based on the present Course of Study which was implemented starting in 1980 in Japan. Science achievement tests, which made use of paper-pencil types of tests, were administered in 1983 by the Ministry of Education, Science and Culture. The sample was selected from among the seventh, eighth, and ninth grade students of the lower secondary schools in Japan. One percent of the total population of students was taken as a sample (about 16,000 students) from each grade level for this study. The selected data on the results of national science achievement tests are shown in Table 1.(23)

The percentage of correct responses on total science achievement test shows 67.4% of the seventh grade, 62.7% at the eighth grade, and 70% at the ninth grade. These results suggest that the achievement levels of students as a whole can be considered as successful. As shown in the percentage of correct responses by objective evaluation points which are knowledge/understanding, observation/experiment skills, and scientific thinking, the achievement levels of students on understanding natural

things and phenomena and observation and experimental skills seem to show success. However, the achievement related to scientific thinking, which are controlling variables, combining variables, interrelating variables, and consistency of logical thinking, was found out to be relatively insufficient. These results suggest that it is very necessary to improve the students' thinking skills in science by letting them have first hand experience with real objects and understand the ideas from real things and phenomena through problem solving processes. The development of cognitive skills in science is one of the most important goals of science education in Japan.

The Second International Science Study (SISS), which is being conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA), was undertaken in 25 nations. The national surveys were coordinated by Jacobson, W. J. in the United States and Miyake, M. in Japan. Samples were taken from fifth, ninth, and twelfth grade students in both countries. Selected data on the results of core international tests are shown in Table 2.(24)

The percentage of correct responses on total core tests shows that there are slight differences (within 5% of each other) in the correct responses in the achievement levels of students between the American population and the Japanese population at each grade level. As shown in the percentage of correct responses by objective evaluation points which are information (knowledge), comprehension (understanding), and application, the achievement levels of Japanese students on comprehension and application are higher than those of American students. These are common tendencies in the fifth, eighth, and twelfth grade populations. On the other hand, the achievement levels of American students on information

(knowledge) are higher than of Japanese students in the fifth and eighth grade populations. Japanese students' scores on comprehension and application are relatively higher than the scores on information in each grade population, while the American students' scores are almost equally balanced on these three categories of objectives. These results suggest that it might be necessary to attain these three objectives, knowledge, understanding, and application, simultaneously in science education in Japan.

The survey to assess the level of cognitive skills in science of junior high school students in Japan and in North Carolina (U.S.) was undertaken by Takemura, Hiroshima University, Japan, and Mattheis, East Carolina University, North Carolina, in 1984. Approximately 3,300 students were selected from 10 different school districts from across North Carolina. The breakdown by grades was approximately 1,000 in grades 7 and 9 and more than 1,300 in grade 8. The Japanese sample was nearly 4,500 students from six prefectures and almost equally divided between the seventh, eighth and ninth grades, with approximately 1,500 in each grade level. In this study, two tests were administered to students in both countries. The first, Group Assessment of Logical Thinking (GALT), developed by Roadrangka, Yeany and Padilla, consists of 12 items designed to assess six reasoning skills. They are, conservation, proportional reasoning, controlling variables, probabilistic reasoning, correlational reasoning, and combinatorial reasoning. Also, the Test of Integrated Process Skills II (TIPS II), developed by Burnes, Wise, and Okey, consists of 36 items designed to assess five integrated process skills in science. They are, stating hypotheses, identifying variables, operationally defining, designing investigation, and graphing and interpreting data.

selected data on the results of GALT and TIPS II tests are shown in Table 3 and Figures 1 and 2.(25)(26)

The overall percentages of correct responses on the GALT test were 50.1% for Japanese students and 30.6% for North Carolina students. The overall percentages of correct responses on the TIPS II test were 60.9% for Japanese students and 48.2% for North Carolina students. In terms of the total scores on the GALT and TIPS II tests, there were significant differences between the students in Japan and North Carolina. However, as shown in Figures 1 and 2, there seems to be similarities in that a positive progression of scores on both tests were observed from the seventh grade to the ninth grade and similar gains were found in students of both Japan and North Carolina. Furthermore, a moderately strong correlation was found between the reasoning skills as measured by the GALT test, and the integrated process skills as measured by the TIPS II test, in each country. The correlation coefficient was 0.64 ($p < 0.0001$) for Japanese students and 0.63 ($p < 0.0001$) for North Carolina students. The results might imply that reasoning skills and integrated process skills might be developed at the given rates and interrelate with each other during the junior high school years (7-9). The differences in cognitive skills levels of students between the two countries at the seventh grade might be explained as a reflection of their experiences during the previous years of education (K-6) and home life.

These kinds of empirical data on student assessment may suggest the need for the improvement of the science curriculum, but more information is needed. In addition to the analysis of the attained curriculum based on student assessment, analyses of current intended curricula and implemented curricula should be done in order to determine their present

status. After the strengths and weaknesses are assessed and future needs identified, then the approaches needed to get the expected status can be determined. This cycle is considered as one of the models of curriculum development and evaluation. Descriptive data on the nature of learners have been extensively accumulated. These studies include various comments on teaching strategies and curriculum organization in science and are especially useful for specific fields in science education. However, almost all these descriptive data have not been organized and synthesized as prescriptive data for the development and implementation of science curriculum in schools. It is very necessary to gather and analyze such data for decision making about science curricula in both countries.

Summary and Conclusion

In this report, the perspective on educational settings and school science curricula in Japan compared with the United States were described and discussed. Concerning external factors influencing the school science curriculum, two main aspects of educational settings were discussed. The first was cultural and societal expectations on education. The hidden purpose of education in Japan, to prepare individuals to play acceptable roles in the modern economic, and technological society, was discussed. In Japan, the roles of education are widely considered as transforming society, development of Man Power as Total Group, and personal advancement. Now Japanese are shifting gears educationally toward internationalization, individualization, and development of creativity. They need to learn from other countries, especially the United States, in order to know themselves.

The second aspect of educational settings, as an outer factor influencing the school science curriculum, was the educational system and school curriculum. The culture and societal expectations on Education reflect on the school system, curriculum decision making, and nature of school curriculum, all of which directly influence the science curriculum. Between Japan and the United States, the interpretations of Equal Opportunity in Education seem to be different, but considered important in both countries. As a result, the single track system was established in Japan in contrast to the United States, who have a multiple track system. The educational systems are different. Japan has a centralized system and the United States has a decentralized system. However, in both countries, the final decision making of curriculum is left up to the classroom teachers. Teachers have "freedom" to modify

their own curriculum. The discrepancy between intended curriculum and implemented curriculum was analyzed. Textbooks and external examinations might influence the classroom teaching (implemented curriculum) in both countries. In general, both countries share the common nature of school curriculum in terms of the attainment of the full development of personality and humanity as a whole.

School science curriculum in Japan compared with the United States was described and discussed in terms of aims and objectives, scope and sequence, and attained curriculum as measured by achievement and cognitive skills tests. The goals of science education are universal in both countries as well as in other countries. The development of "scientific and technological literacy" for all students is the main target for the 21st century. In order to attain this goal, curriculum contents are organized as scope and sequence. Basically, the school science curricula are similar in both countries in terms of specialized subjects focused on the natural and technological environments of humans, although the approaches to course offering are different. The attained curriculum, which are the contents students learn as a result of experience in the classroom, was analyzed and discussed in terms of the development of cognitive skills in science. The differneces between Japanese and American culture, social background, school system, and school curriculum might be possible causes for differences in the cognitive performance of students. In order to improve the students' cognitive skills, analyses of the intended curriculum and implemented curriculum are still needed. As educational researchers, what we can do and should do to improve the daily educational activities in schools, which is embodied as "lessons," is to provide the prescriptive data on the nature of the learner. Although the

cultural milieu around learners is different, the nature of the learner is fundamentally the same beyond culture. Therefore, pursuing and finding out the nature of learners will lead to the development of universal principles of science curriculum foundations which can be shared mutually.

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APPENDIX

TABLE 1. The Result of National Science Achievement Tests in Japan

- Achievement Scores by Objectives -

Percent Correct (%)	7th	8th	9th
Total Score	67.4	62.7	70.1
OBJECTIVE EVALUATION POINTS			
Knowledge/Understanding	71.1	64.1	68.5
Observation/Experiment Skills	74.6	68.7	75.0
Scientific Thinking	59.7	57.7	70.8

TABLE 2. The Result of Second IEA Science Study in Japan and the United States

- International Core Test Scores by Objectives -

Percent Correct (%)	5th		8th		12th	
	USA	JAPAN	USA	JAPAN	USA	JAPAN *
Total Score	60.2	64.3	63.1	67.4	64.3	69.3
OBJECTIVE EVALUATION POINTS						
Information (Knowledge)	59.6	52.3	61.9	56.0	65.5	66.7
Comprehension (Understanding)	63.8	73.9	63.4	72.4	62.3	68.3
Application	58.0	62.7	63.5	70.2	65.8	70.7

* Average Scores in the Total 12th Grade Populations

TABLE 3. The Result of U.S.-Japan Cooperative Science Project

- GALT and TIPS Test Scores -

Percent Correct (%)	TOTAL		7th		8th		9th	
	N.C.	JAPAN	N.C.	JAPAN	N.C.	JAPAN	N.C.	JAPAN
GALT TOTAL SCORE	30.6	50.1	26.4	44.8	30.8	49.9	34.4	55.6
TIPS TOTAL SCORE	48.2	60.9	46.1	57.1	47.2	59.8	53.1	65.6

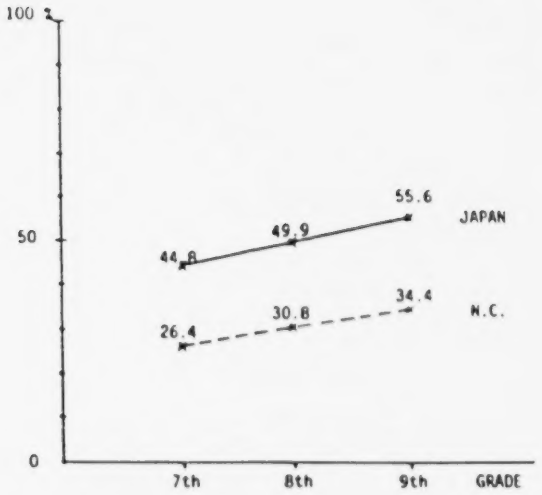

FIGURE 1. GALT Test Total Scores by Grade

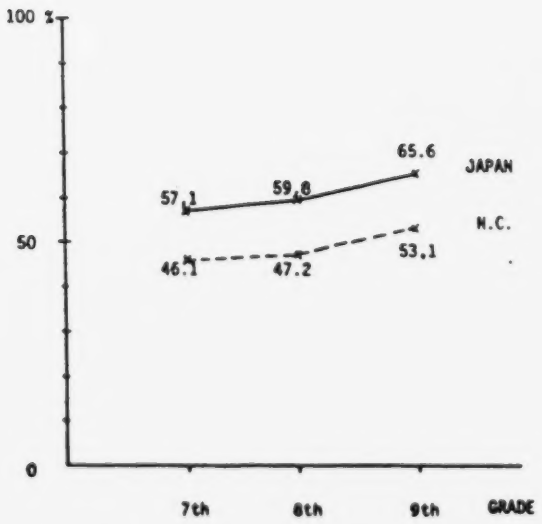

FIGURE 2. TIPS Test Total Scores by Grade